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LANDER RESOURCE AREA

REMOTE SENSING PROJECT

Final Report

Submitted by

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1.0 Introduction

The BLM's Branch of Remote Sensing (BRS) was created in 1979 for the purpose of conducting operational remote sensing activities and fulfilling a service capacity to the BLM field offices. Remote sensing output products in the form of maps and tabular reports are designed to aid resource inventory and management programs within the jurisdiction of the BLM field offices. This report will document the remote sensing inventory project conducted in cooperation with the Rawlins District (RDO), Lander Resource Area (LRA), and Wyoming State Offices (WSO). The project was conducted in the Lander Resource Area, which is composed of the Moneta, Sweetwater, and DuBois Planning Units. The Gas Hills inventory Area includes the DuBois Planning Unit and portions of the Moneta and Sweetwater Planning Units (Figure 1).

As a result of a BLM reorganization in 1982, the BRS is now called Scientific Systems Applications (SSA). The BLM's Digital Image Analysis Laboratory (DIAL), housed at the Denver Federal Center, operates an Interactive Digital Image Manipulation System (IDIMS) implemented on an HP-3000 computer. Technical efforts of SSA are supplimented to a major extent by contract support staff provided by Technicolor Government Services, Inc.

The major emphasis of this report is to document the procedures employed to generate specific resource maps and tabular reports requested by RDO and LRA. The sequence of activities leading to the generation of output products and digital processing tasks reported in this document are similar, in a generic sense, to other remote sensing vegetation mapping projects conducted at SSA. LRA project planning and coordination was initiated in October 1981 and the generation of final products was completed in November 1982.

2.0 Objectives

In October 1981, a planning and coordination meeting was held in Lander and Rawlins to discuss specific inventory needs of the resource area and district. Upon conclusion of this meeting, the project objectives were formulated. To aid the district SVIM inventory teams, the project objectives were to generate a spectral classification utilizing Landsat digital data. The spectral classification was used in combination with soils data to develop information on range sites. In order to support the broad planning and inventory needs of the Rawlins District, the objective was to provide land cover maps, woodland type maps, range suitability maps, and tabulations of land cover acreages compiled by ownership class within each BLM grazing allotment.

To summarize these objectives, products derived from a geographic data base composed of Landsat data, terrain data, land status, grazing allotments, water sources, and soils data were intended to support the

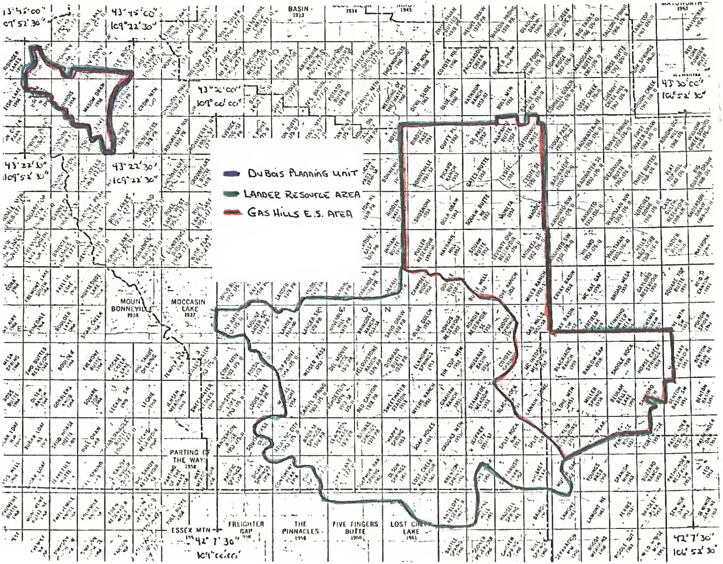

Figure 1. Approximate Project Boundaries for Lander Resource Area Plotted on an Index of 7.5 Minute Topographic Quadrangles.

following activities to be accomplished by the district and resource area personnel: 1) environmental statement for Gas Hills, 2) woodland inventory (non commercial softwoods and hardwoods), and 3) SVIM inventory.

3.0 Project Area

The project area is located in the Wind River Basin and Gas Hills area in north central Wyoming generally between latitudes 40°07'30" N and 43°45'00" N and longitude 107°00'00"W and 110°00'00"W. The project area corresponds to the boundaries of BLM's Lander Resource Area. The Wind River Indian Reservation and the Riverton Withdrawal Reclamation Area occupy large land areas within the Lander R.A. Smaller tracts of private and state lands are interspersed among more extensive tracts of BLM land within Lander R.A.

The Wind River Basin lies between the Wind River Mountains on the south and the Absaroka, Owl Creek, Bridger, Copper, Lysite and Big Horn Mountains along the northern boundary. The Wind River drainage includes an area sixty miles to the east of Riverton and spans sixty miles to the north and south between the mountain ranges.

Average annual percipitation ranges from approximately 5 to 9 inches at lower elevations and 10 to 14 inches at higher elevations. The elevation ranges from 6,900 feet at DuBois to 4,700 feet at Shoshoni with an average near 5,000 feet. The Sweetwater River drains the area between Granite and Green Mountains in the southern portion of the Lander Resource Area. Elevation in this portion of the project area reaches 9,125 feet on Green Mountain with precipitation in the 15 to 19 inch range. The Gas Hills Area, east of Riverton, is the center for oil, natural gas, and uranium in the state.

The Bureau of Reclamation has sponsored an extensive irrigation project in the Riverton area. The availability of irrigation water has promoted the development of commercial farm operations which provide high value crops such as sugar beets and small grains. Livestock grazing is extensive throughout the basin. Livestock ranching and cash-crop farming combine to make the area a stable agricultural community. In addition to livestock, there are extensive herds of resident pronghorn antelope grazing the area. Migrant herds of elk and deer appear throughout the mountain ranges.

Geology in the Wind River Basin is primarily tertiary sandstones and clay shale. The Wind River Mountains, Copper Mountains, and other areas of higher relief are chiefly granite. The city of Lander and adjacent areas to the west are residing on carboniferous limestones, redbed sandstones, loamstones, and clay shale. Breccias and rhyolites are found east of Lander in a narrow north-south strip. The southern portion of the project area adjacent to the Sweetwater River is tertiary tuffaceous sandstones, clay shale, and marlstones, with granite outcrops at higher elevations.

The major vegetation in the project area can by typified as intermountain shrub. The mountainous regions support mixed conifers. Big sagebrush is the most widely distributed shrub below 6,000 feet elevation, however, there are abundant grasses interspersed among the sagebrush and other shrubs. Along the Wind River drainage cottonwood, willow, and Russian Olive are the dominant riparian species. Garner saltbush, budsage, and shadscale are common shrubs. Grasses include Indian ricegrass, western wheatgrass, needle and thread, bottlebrush squirreltail, and sandberg bluegrass. Along the foothills, where precipitation is higher, the woodland species are aspen, juniper, and limber pine. Grasses include bluebunch wheatgrass, western wheatgrass, blue grama, prairie junegrass, and sandberg bluegrass. Shrubs include big sagebrush, black sagebrush, and silver sagebrush. Black sagebrush is often found on poor, shallow soils. Silver sage occurs at higher elevations with higher precipitation. Blue spruce, lodgepole pine, and ponderosa pine are dominant species on Green Mountain.

4.0 Data Acquisition

The project utilized data derived from several sources. Principal data types included Landsat(satellite) data, digital terrain data, USGS topographic maps and orthophotos, soils maps, water sources, land status and administrative boundaries.

4.1 Landsat Data

As a result of the location and and prodigious size of the project area, four Landsat scenes were required to provide coverage of the Lander Resource Area. All of the required Landsat spectral data in the form of computer compatible tapes (CCT's) were received at BLM's DIAL in October 1981.

The Landsat data were acquired from the Multispectral Scanner (MSS) aboard Landsat 2. Table 1 provides identification of the Landsat data utilized in this project. The Landsat data obtained for the project represented the best available combination of high quality imagery and most recent date of seasonal coverage to capture native vegetation in the desired phenological stage. Figure 2 is a mosaic of 3 Lander Resource Area Landsat scenes.

4.2 Digital Terrain Data

Digital terrain data compiled by the Defense Mapping Agency (DMA) from standard 1:250,000 scale USGS topographic maps were obtained for the entire project area from USGS's National Cartographic Information Center (NCIC).

Project Area Coverage	Scene I.D. Number	Date	Worldwide Reference System	
			Path	Row
DuBois Planning Unit	2125217023	June 27, 1978	40	30
Lander Resource Area (West)	2200717173	July 21, 1980	39	30
Lander Resource Area (S.West)	2200717160	July 21, 1980	39	31
Lander Resource Area (East)	2197017105	June 14, 1980	38	30

Table 1. Landsat Data Acquired For The Lander Resource Area Remote Sensing Project

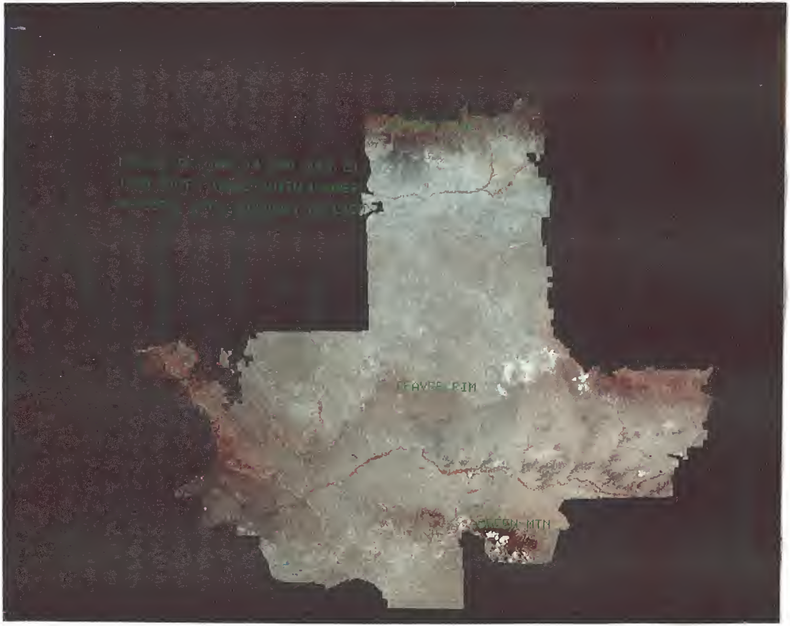

Figure 2. Landsat Images of Lander Resource Area (Excluding DuBois Planning Unit).

DMA tapes contain elevation data recorded at 208 foot (63.5 meter) grid intervals. Each file on the DMA tape represented an area of one degree by one degree. Several one degree blocks were required to cover the entire project area. Digital Elevation Models (DEM) which provide greater terrain detail and accuracy were not available at the time that the project was initiated.

4.3 Aerial Photography

High quality natural color aerial photography (scale = 1:24,000) was available for the entire project area. The photography was obtained during the summer months of 1980 and 1981. A majority of the photography was acquired at nearly the same date as the Landsat imagery in 1980. The photography was not used as a source of quantatative data derived through photo interpretation measurements. Rather, the aerial photos were utilized in a user workshop at Denver Service Center (DSC) to aid LRA range conservationists in determining which Landsat spectral classes represented specific vegetation and land cover types.

4.4 USGS Topographic Maps and Orthophotos

A complete set of 1:24,000 scale orthophotos for Lander Resource Area (excluding DuBois Planning Unit) was supplied by the Wyoming State Office of BLM. The orthophotos had great utility in facilitating ground control point selection (Section 5.2.1.1). The Wyoming State Office also provided one set of 1:24,000 topographic map transparencies for the Gas Hills Area.

4.5 Land Status, Allotment-Pastures and Water Sources

In preparation for digitizing, land status was transferred from BLM Master Transfer (MT) plats to the stable-based topographic map transparencies supplied by WSO. Topographic maps (1:24,000 scale) showing allotment-pasture boundaries and water sources were supplied by the LRA office. These "working maps" were returned to LRA after the data were digitized at BLM's DIAL.

4.6 Soil Maps

Soil Maps (transparencies) for the Gas Hills 7.5 minute quadrangles (excluding DuBois Planning Unit) were supplied by WSO. Sufficient funds were not available to have the soils polygons digitized by an outside contractor. Furthermore, the human resources and equipment at the DIAL was not sufficient to digitize thousands of soil polygons "in-house". A decision was made to use the soils transparencies as graphic overlays to be viewed with spectral color-coded maps derived through digital processing of Landsat data (Section 5.3.3.1).

5.0 Technical Approach

In the sections that follow, a detailed description of digital processing tasks will be documented for the Lander Resource Area remote sensing project. The technical emphasis of the project was directed to various digital processing tasks in order to produce map products and reports requested by the Rawlins District and Lander Resource Area.

A land cover classification scheme was prepared to insure that the final map products would include the major vegetation and land cover types that occur in the Lander Resource Area. A short discussion on the preparation of the land cover classification will precede the digital preprocessing and digital processing sections.

5.1 Land Cover Classification Framework

Land cover maps were one of the major map products delivered to the Lander Resource Area Office. In any land classification effort, whether the primary data source is satellite data, aerial photography, or ground data, it is necessary to prepare a land cover classification framework to insure that vegetation and land cover types of interest to the user will be represented in the final map products.

Classification systems attempt to group similar land-use/land-cover patterns in a rational linkage or hierarchy based on common attributes. A methodical classification system can be developed only through the establishment of hierarchies of classes, and such classes also permit inductive generalizations. One unfortunate feature of the "logical division" approach is that all possible features must be included; therefore the end result invariably includes a catch-all miscellaneous or other category.

One of the primary virtues of a hierarchical classification system is that it is structured for developing categories at more detailed levels. This feature also permits subsequent aggregation or disaggregation of land units without difficulty. The land cover classification framework prepared for Lander Resource Area is described in Figure 3.

5.2 Digital Image Preprocessing

Several routine digital manipulations of Landsat data and terrain data were required prior to initiating the classification phase. These manipulations served the following purposes:

a. a reformatting of the data so that it was compatible with BRS's Interactive Digital Image Manipulation System (IDIMS) software.
b. The removal of radiometric anomalies (eg., line drops, banding, or stripping) from the original Landsat data.

Figure 3
Land Cover Classification For
Lander Resource Area - Wyoming

Level 1 (Biome)	Level 2 (Formation)	Level 3 (Association)
(1) Agricultural Land	(11) Cropland And Pasture	(111) Cropland
		(112) Pasture
(2) Forest Land	(21) Mixed Conifer	(211) Blue Spruce/Lodge Pole/ Ponderosa Pine
		(212) Lodgepole Pine
		(213) Limber Pine
		(214) Limber Pine/Juniper
	(22) Broadleaf Deciduous	(221) Upland Aspen
		(222) Cottonwood/Willow
(3) Range Land	(31) Juniper/Shrub	(311) Juniper
		(312) Juniper Sagebrush
	(32) Shrub/Juniper	(321) Sagebrush/Juniper
	(33) Shrub	(331) Sagebrush
		(332) Sagebrush/Other Shrub
	(34) Shrub/Mixed Grass	(341) Sagebrush/Mixed Grass
		(342) Other Shrub/Mixed Grass
	(35) Desert Shrub	(351) Greasewood/Attiplex
	(36) Riparian Shrub	(361) Willow/Other Shrub
	(37) Mixed Grass/Shrub	(371) Mixed Grass/Sagebrush
		(372) Mixed Grass//Other Shrub
	(38) Mixed Grass	(381) Mixed Grass
	(39) Riparian Grass	(391) Riparian Grass/Sedge
(4) Barren Land	(41) Natural Features	(411) Exposed Surface Rock
		(412) Bare Soil
	(42) Cultural Features	(421) Mines
		(422) Dry Stockponds
		(423) Buildings/Other Structures
(5) Water	(51) Streams	
	(52) Lakes & Reservoirs	
	(53) Stock Ponds	

c. The removal of geometric distortions which were inherent in the Landsat data and registration of the data to a map projection.

Digitizing map data has been included in this section as a form of preprocessing. Point, line, and area data were entered through the Geographic Entry System (GES) at the DIAL and the resultant files were accessed to produce rasterized images compatible in format to the Landsat and terrain data.

5.2.1 Radiometric and Geometric Correction

The Landsat data (CCT's) acquired for the LRA project were identified in Table 1. The first step in preprocessing these data was to enter the data into IDIMS. The IDIMS function LANDSAT was employed to enter the 4 band EDIPS image from the source tapes acquired from the EROS Data Center. Each of the Landsat scenes were entered separately. Next, a subsection of each scene was selected to eliminate data that was outside of the area of interest. A 1:250,000 scale topographic map with the LRA boundary superimposed was used as a guide to determine what portions of the Landsat scenes would not need to be processed.

Each image was examined to locate bad data lines. No bad data lines were detected. The June image contained some noticable striping in one of the infrared bands. This banding or striping was the result of sensor miscalibrations or difference in response characteristics of the 24 detectors within the MSS sensor. The IDIMS function DESTRIPE was employed unsuccessfully as the striping was still apparent in the data.

The raw data on Landsat tapes needed to be geometrically corrected and registered to a map-based coordinate system such as Universal Transverse mercator (UTM). Geometric errors can be either systematic or non-systematic . Systematic errors include: 1) scanner distortion, 2) mirror velocity variation, or 3) scan skew. Non-systematic errors include: 1) earth rotation, 2) spacecraft velocity, 3) altitude variation, 4) pitch, 5) roll, and 6) yaw. Control point selection is the first step in geometric correction.

5.2.1.1 Ground Control Point Selection

Ground control point (GCP) selection involves the technique of locating pixels in the Landsat data that can be plotted in their corresponding or matching location on a base map. Orthophotos were used to plot the control point location of each pixel selected. An average of two GCP's were selected per orthophoto. Each selected pixel was given an identifier label by the analyst and the line and sample location of each pixel was automatically stored in a mensuration file. The matching point plotted on the orthophoto was assigned the same label name. Two hundred and fourteen (214) GCP's were selected throughout the Lander Resource Area excluding DuBois Planning Unit [1]. GCP's were systematically spaced to provide a good distribution of points throughout the LRA. Where two images overlapped, an effort was made to locate the same pixel on each image to create a good registration (edge match) from one image to another.

5.2.1.2 Digitize GCP's

A geoblock or geographic data base was set up in the Geographic Entry System (GES). A control point overlay file was created. Each orthophoto was registered separately by entering the latitude-longitude coordinates of the 4 corners and 4 internal coordinates. Each GCP was digitized and labelled.

5.2.1.3 Develop Transformations

The IDIMS utility function ALLCOORD was used to convert GES latitude-longitude coordinates of GCP's to a 50 meter UTM grid. The IDIMS utility TRNSFORM was used to develop a T^2 and T^3 transformation. The T^2 related the GES "source points" to the ALLCOORD UTM "destination points". The T^3 transformation related the Landsat line/sample values of GCP's to the desired output grid, in this case a 50 meter UTM grid. The T^3 transformation listed the residual error of each GCP and the residual mean of all GCP's. Residual means for the 214 GCP's were well under 1/2 pixel or 25 meters. This indicated that the center of any pixel within the Landsat data was less than 25 meters from the actual location on the ground.

5.2.1.4 Register Landsat Data

The IDIMS function REGISTER applied the T^3 transformation to the uncorrected Landsat images to create geometrically-corrected images registered to a 50 meter UTM grid. Separate transformations were applied to register the June and July scenes. The two July scenes were MOSAICed to form one image.

5.2.1.5 Apply Resource Area Boundary

The resource area boundary was digitized from 7.5 minute quadrangles and a rasterized image was created by employing the IDIMS utility STRATA followed by the IDIMS function BLDSTRAT. The STRATA program converted the data file to UTM by applying the T^2 transformation. BLDSTRAT created an image or "mask" of the resource area. The resource area mask was MULTIPLYed with the registered images (June & July) then CONVERTed from integer to byte data. The resultant images contained data only within the LRA and eliminated pixel data external to the project area.

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[1] The DuBois geometric correction was performed during a pilot project in FY81 that preceded the expanded LRA Project.

5.2.2 Terrain Data

The DMA digital terrain data (DTD) tapes represent elevations along scan lines that run vertically from map bottom to map top. After the DTD data was entered into the system using the IDIMS function TERRAIN, the elevation image was formatted to the IDIMS line, sample structure[2]. However, map north was located at the right side of the image, ie., rotated 90 degrees from its map origin.

5.2.2.1 Rotate DMA Data

Each one degree by one degree block was rotated by using the IDIMS utility functions ALLCOORD and TRNSFORM. The IDIMS terrain function generated a print-out that provided the line, sample coordinates and latitude-longitude coordinates of the 4 corners. Eight ALLCOORD text files were created by typing in the coordinates of the SW, NW, NE and SE corner for each 1° by 1° block. The UTM origin and grid cell size were specified the same as described when registering the Landsat data (Section 5214).

5.2.2.2 Develop Transformations

Lander Resource Area overlaped two UTM zones (zone 12 & 13) and the UTM origin was in Zone 12. When entering terrain data from UTM Zone 13, the first quad corner and lat.-long. coordinates were bogus and actually represented a location in UTM Zone 12. The program ALLCOORD reads the lat.-long. coordinates of the first corner entered and assigns the UTM zone where that point resides. If the bogus or dummy coordinates for UTM Zone 12 were not entered first, the computer would assign the data to the wrong origin in UTM Zone 13 and the data registration would be incorrect. The dummy coordinates were deleted from the ALLCOORD text file after the program ran successfully.

5.2.2.3 Register DMA Data

TRNSFORM uses the "source" points (lat-long corners) in the ALLCOORD text file to assign the "destination" points (image relative line, sample coordinates) of the corresponding corners. The transformation records were applied to register the DMA data to the Lander Resource Area 50 meter UTM grid.

5.2.2.4 Generate Elevation Image

To generate one composite elevation image for the Lander Resource Area (excluding DuBois PU), the separate registered DMA quadrangles were combined through the use of the IDIMS function MAX. The composite integer elevation image was CONVERTed to byte data. The byte image was examined for bad data lines and none were found. The image was then MAPped to create 50 meter data intervals. The Lander Resource Area boundary mask was MULTIPLYed with the 50 meter elevation image and CONVERTed to byte data. The 50 meter byte elevation image was combined with the classified image to create elevation strata that were utilized in the LRA user workshop (Section 5.3.2)

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[2] The tape recognition label must be turned off when TERRAIN is used to enter DMA data. A special program was used to perform this task.

5.2.2.5 Generate Slope Image

The Gas Hills boundary was MULTIPLYed by the 50 meter elevation image. The resulting integer image was used as an input image with the IDIMS function SLOPE2. Slope2 created a byte image containing data in slope percent. The slope percent images were mapped to 6 slope classes using BLM criteria. The 6 slope classes were as follows: 1) 0%, 2) 1-20%, 3) 21-30%, 4) 41-50%, 5) 50%. The slope class image for Gas Hills E.S. Area was used in conjunction with distance to water images to produce range suitability maps (Section 5.3.3.5).

5.2.3 Map Digitizing

Topographic maps with land status, allotment-pastures, and water source locations were obtained from the Wyoming State Office and Lander Resource Area Office. New overlays were created in the GES geoblock of Lander Resource Area to accommodate data entry for each of the three themes mentioned above.

5.2.3.1 Land Status

Land status was digitized from 7.5 minute maps of the Gas Hills E.S. Area (including DuBois PU). Land status maps included all BLM, state, private, U.S. Fish and Wildlife, Bureau of Reclamation and Wind River Indian Reservation lands. Land status maps for the remainder of Lander Resource Area were not updated and therefore, not available for the project. The land status data was combined with allotment and vegetation data in tabular reports to be discussed in more detail in Section 5.3.3.6.

5.2.3.2 Allotment-Pastures

Allotment and pasture polygons were drawn on 7.5 minute topographic maps by Lander Resource Area range conservationists. The LRA "work" maps were sent to DIAL for digitization. Because these maps were a working set and needed for periodic referral, the LRA range conservationists preferred to send the maps in two shipments to insure that some of the maps would be available in the office while the rest were being digitized. The first shipment contained approximately 1/2 of the allotment-pasture maps, in alphabetical order beginning with the letter A. When the first shipment of maps were digitized and returned, the second shipment of alphabetically-referenced maps were sent by the LRA Office.

A problem was encountered in matching allotment lines between maps digitized from the first shipment with the maps received in the second shipment. Several conflicts in allotment line boundaries were encountered where either an allotment line on one map did not continue on to the adjacent map or the line was in a different location on the adjacent map. A special trip was made to Lander to correct the maps to insure that adjoining allotment lines matched properly from map to map.

The line matching problem could have been resolved faster and easier if the two shipments of maps were sent in blocks such as top (north) half first and bottom (south) half second rather than in alphabetical order. Perhaps the best procedure would be for a technician from DIAL or the area office to hand transfer the allotment lines from the "source" maps to a duplicate set of maps. Then the entire duplicate set would be used for the digitizing task.

As the result of the large number of allotments occuring within the LRA and the nature of the map shipment, five area overlay files were created to accommodate the digitizing of the allotment-pasture polygons. The incorporation of the allotment data with land status and vegetation data in tabular reports are discussed in Section 5.3.3.6.

5.2.3.3 Water Sources

Water sources were outlined on 7.5 minute topographic maps received from the LRA Office. Water sources in the Gas Hills E.S. Area included wells, streams, and reservoirs. Therefore, point, line, and area overlays were opened in GES to accommodate these data. There were no problems encountered in digitizing water sources and the task was completed in less than 4 hours.

5.3 Digital Image Processing

The first sequence of digital processing steps were devoted to the generation of multispectral classifications. These classifications were conducted on the IDIMS system using an unsupervised, controlled clustering procedure and a maximum likelihood classification algorithm. Once the multispectral classifications were generated, the next sequence of digital processing tasks employed were dependent on the specific type of output products that were requested for each sub-project area.

5.3.1 Multispectral Classification

Five separate classifications were performed to accommodate the different sub-project areas and Landsat data sets described below.

Sub-Project Area	Landsat Data Sets
DuBois Planning Unit	June 27, 1978
Lander Resource Area (excluding DuBois PU)	July 21 & June 14, 1980
Gas Hills E.S. Area	July 21 & June 14, 1980

Essentially, the same general procedures were followed to generate a multispectral classification for each data set. The sequence of steps in the classification were: 1) data reduction, 2) unsupervised classification, 3) statistics file editing, and 4) maximum likelihood classification.

5.3.1.1 Data Reduction

In order to prepare a data set to be used in an unsupervised classification, it was useful to eliminate extraenous data. The objective of this task was to reduce the amount of computer time required to generate a statistical file of spectral cluster classes.

The IDIMS function RAVEL required two input images and produced one output image of compressed data that had no geometric orientation or interpixel relationship. The first input image was the registered 4 band multispectral image with boundary applied. The second image was a 4 band image of the boundary mask. All zero data (fill) and data outside of the project boundary were eliminated and the output image contained only the data set of interest. The next step was to perform the function REDUCE or MAGNIFY on the RAVELed image. REDUCE or MAGNIFY can provide the same results by creating an image with only 1/4, 1/8 or less data than is contained in the input image. A representative sample of the data was acquired while reducing the amount of data to be processed. MAGNIFY was used on larger data sets because the function is launched on the Advanced Scientific Array Processor (ASAP) and generally processes faster than the HP-3000.

5.3.1.2 Unsupervised Classification

The RAVELed-REDUCEd image, in most cases, contained less than 512 by 512 pixels to expedite the unsupervised classification. The IDIMS function ISOCLS performed unsupervised classification of the multispectral RAVELed-REDUCed image using a clustering algorithm. The algorithm partioned the set of multivariate data points into disjointed sets of "statistically similar" data points. The following parameters were specified for the ISOCLS function: STDMAX=4.5, DLMIN=2.8, ISTOP=15, MAXCLS=50. The explanation of these parameters and the strategy for setting the values at specific levels will not be discussed. The values assigned to the ISOCLS parameters are included here for purposes of documentation only.

5.3.1.3 Statistics File Editing

Some minor editing of the spectral clusters in the ISOCLS statistics file was necessary to evaluate and prepare a suitable file to be used in the creation of a classified image. The IDIMS function SMART was employed to edit the statistics file. Inevitably, one of the cluster classes contained zero values. This class was deleted immediately. The resulting file was COPYed in order to save or "backup" the original file. Additional editing was performed on the duplicate file and the original file was only used if the duplicate file was lost or altered in a way that was not satisfactory to the analyst.

To begin the evaluation process, three "tools" were employed to scrutinize the statistic files. First, SMART generated a printout that listed the mean, standard deviation, covariance matrix, and number of pixels pertaining to each cluster class in the file. Next, the same file was specified in the IDIMS utility COMPAR2 to produce a hard copy display of the mean and standard deviation plotted with band 2 (red) and band 4 (near infrared) on a two dimensional axis. Then, the file was used with DIVERGE to create a table of threshold divergence values which indicate the amount of separability between any two spectral cluster classes[3]. Generally, any cluster with a large standard deviation and a very small number of pixels was deleted. The cluster pairs that had very low threshold divergence (500) were combined in some cases, although other considerations influenced the decision to delete or combine clusters. SMART, COMPAR2, and DIVERGE were repeated until a final acceptable edited statistics table was generated.

5.3.1.4 Maximum Likelihood Classification

The function CLASFY classifies a multiband input image into spectral types according to spectral statistics contained in the previously constructed (edited) statistics file, by using a maximum likelihood decision rule. The 4 band registered multispectral image with boundary attached was the input image. Two output images were generated by CLASFY. The most important was the classified image itself. The second output image depicted chi square look-up values between 1 and 15. PIXCOUNT generated a list of the cluster classes and the number of pixels that were classified to each cluster class.

5.3.2 Lander Resource Area User Workshop

Two user workshops were conducted at BLM-DIAL with range conservationists from LRA in attendance. The first workshop occurred in February 1982 and the second workshop was in July, 1982. The objective of the user workshop was to allow the LRA range conservationists to assign spectral cluster classes to resource information or land cover classes. Preliminary land cover maps generated after the first user workshop required some revisions, therefore the second workshop was conducted to re-assign some of the spectral cluster classes to land cover classes. The elevation image was MAPped, MULTIPLYed by the clasified image and CONVERTed. Elevation strata were developed at 6800 and 7800 feet for the Lander Resource Area data set. An elevation break was made at 7600 feet for DuBois Planning Unit. The elevation strata helped to distinguish between two or more vegetation types that had similar spectral reflectance characteristics but occurred in different elevation zones. A land cover mapping number was assigned to each spectral class. Each elevation stratum was MAPped and the strata were recombined into one complete land cover image using MAX.

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[3] Values range from 0 to 2000. A low value indicates a high amount of separability, and a high value indicates low separability.

5.3.3 Generation of Map and Tabular Output Products.

Several types of output products were requested by the district and area offices. Most of the output maps were generated on the 7.5 minute format to facilitate their evaluation and subsequent use in the field. The specific procedures used to generate each type of output product will be discussed.

5.3.3.1 Gas Hills Soil-Spectral Maps

In the October 1981 planning and coordination meeting, the output products to be delivered to the district and area office were defined. The generation of spectral-soil maps were considered the first priority because the district SVIM teams wanted to evaluate the maps during FY82 field season.

Thirty, 7.5 minute soil maps for the Gas Hills Area were received from the WSO. The objective was to generate spectral maps for the Gas Hills quadrangles and overlay the soil boundarys on the spectral maps. Preliminary spectral maps, one set displaying 20 color-coded spectral classes and another set displaying 30 classes, were sent to the district office for evaluation. The district SVIM supervisor recommended that the Gas Hills spectral maps be generated with 30 spectral classes because 30 classes provided more detail and depicted subtle differences in soil-vegetation reflectance which were less discernable with only 20 spectral classes.

In order to extract spectral data for any 7.5 minute quadrangle, an overlay of the 7.5 minute quadrangle network was created in GES through the File-A-Grid program. A strata mask file was created from the GES grid overlay and the file was accessed using the IDIMS function STRATCPY to create a spectral image where the pixels (line & sample coordinates) corresponded to the desired quadrangle area. The IDIMS function MAGNIFY was applied to produce scaled images that matched the 7.5 minute (1,24:000 scale) format. The quadrangle size, spectral images were written to TRANSFER tape and ENTERed into the I^2S system for further processing.

A color table was created to assign a unique color to each of the 30 spectral classes. The I^2S functions DISPLAY, FETCH, FEEDBACK (Color Cascade) and APPLICON were employed to generate image files that were read and plotted by the Applicon ink-jet plotter. A legend of the 30 color-coded classes was created by using IDIMS functions ANNOTATE, CONSTANT, INSERT, and TRANSFER and the I^2S functions ENTER, DISPLAY, FEEDBACK, and APPLICON. The color-coded legend was then plotted.

5.3.3.2 Lander Resource Area Land Cover Maps

The first step was to create an image that combined the land cover data and allotment boundaries. An image depicting allotment boundaries was created from a STRATA graphics file. The graphics file (bit data) was brought into the IDIMS format using FILE ENTERIN and ENTER. The bit image was CONVERTed to a byte image[4]. The byte image was MAPped to a value larger than the values (land cover classes) assigned to the land cover image. By specifying the mapped allotment and land cover images as input, the function MAX created a new land cover image with allotment boundaries superimposed. This processing was accomplished for both the detached DuBois Planning Unit and the larger Lander Resource Area image.

To conserve on map production costs, a decision was made to produce black and white symbol maps for the approximately 120, 7.5 minute quadrangles that composed the Lander Resource Area (excluding DuBois PU). The symbol maps (each symbol depicts a land cover class) were generated on the Versatec electrostatic plotter which is much cheaper to operate than the Applicon plotter. The Versatec symbol land cover maps for LRA were generated using the IDIMS functions STRATCPY, MAGNIFY and SYMBPLOT. A character code in the SYMBPLOT pattern file "DEFAULTS" was applied to generate these maps. An example of the land cover VERSATEC product is provided in Figure 4.

Applicon color-coded maps were generated for the DuBois PU, which was composed of only 10, 7.5 minute quadrangles. The DuBois Applicon maps were produced by applying the same processing functions as described in Section 5.3.3.1). A new color table and legend was generated and applied to produce these maps.

5.3.3.3 Small Scale Land Cover Maps

Small scale Applicon land cover maps (with allotment boundaries displayed) were generated for DuBois PU at 1:126,720 scale (Figure 5). LRA maps (excluding DuBois PU) were produced at a scale of 1:250,000.

[4] The CONVERT program runs on the ASAP (Array Processor), however, the ASAP cannot accommodate bit data. Therefore, the ASAP was disabled, so CONVERT would run on the HP-3000 instead.

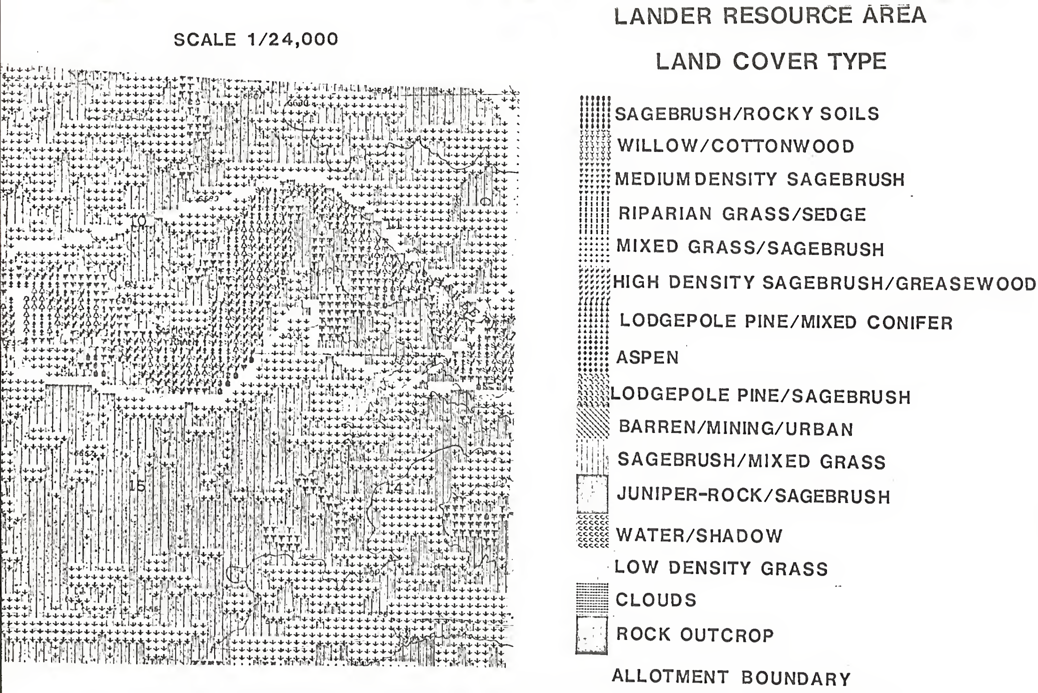


Figure 4. Land Cover Types Displayed on a Portion of the Myer Ranch 7.5 Minute Quadrangle.

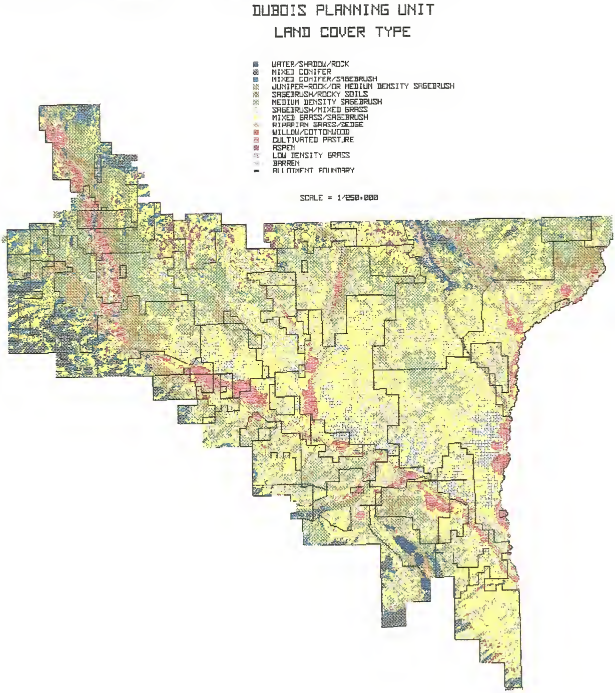


Figure 5. DuBois Planning Unit Land Cover Types Displayed On A 1:250,000 Scale Applicon Map

ANNOTATE, CONSTANT, and INSERT were applied to create the legends. A REDUCEd image of LRA had to be generated because the I^2S Applicon function would not accept the large amount of data in the full image. A 100 meter allotment image was created be compatible with the reduced 1600 by 1900 line-sample land cover image. The I^2S function ENCODE was applied to eliminate some bogus residual lines in the allotment image that resulted from a "bug" in the IDIMS function STRATA when the 100 meter allotment graphics file was created.

5.3.3.4 7.5 Minute Woodland Type Maps

The same quadrangle-size land cover images were used to create woodland type maps. A new character code for the function SYMBPLOT was created to print out 53, 7.5 minute Versatec symbol maps of woodland types.

The character code specified only the woodland classes and some non-woodland classes of interest. Other non-woodland classes (ie., grass & sagebrush class) were not plotted on the woodland type maps. An example of a woodland type map is shown in Figure 6.

5.3.3.5 7.5 Minute Range Sutability Maps

Water sources for the Gas Hills ES Area highlighted on 7.5 minute maps were received from the LRA office. Water sources were digitized at the DIAL using GES. Wells and ponds were digitized into a point overlay. Rivers were digitized into a line overlay and reservoirs, lakes and larger ponds were digitized in an area (polygon) overlay. Strata files were created from the line and area overlays. BLDSTRAT created raster images from the line and area files. Several steps were required to create an image of the point overlay file. First, ALLCOORD created a text file of the point water sources. The first point entered was a dummy point so that the ALLCOORD program would put the UTM origin in the correct zone (UTM Zone 12). The program EDITOR was run to delete the bogus point from that file. The text file was reformatted using the Minitab software. A Fortran program (PimaPro3.Baker.Linden) was written to create a image related file. A raster image was created by using FILE ENTERIN, ENTER, and CONVERT.

One composite image of point, line, and area water sources was created by MAX. The two byte images of water sources (DuBois & LRA) were delivered to EROS Data Center and a "radius search" program was applied to the data. The image prepared at EROS contained values that ranged from 1 to 130. Four miles is the maximum distance that cattle will walk to drink water according to BLM guidelines. The maximum value of 130 multiplied by 50 meters (pixel size) is 4 miles.

The distance to water image was MAPped to five classes. The data mapped to class 10 contained a distance to water of less than 0.3 miles. Class 20 equaled 0.3 to 0.4 miles to water. Class 30, 40, and 50 equaled 0.4 to 0.6, 0.6 to 4 miles and, greater than 4 miles to water,

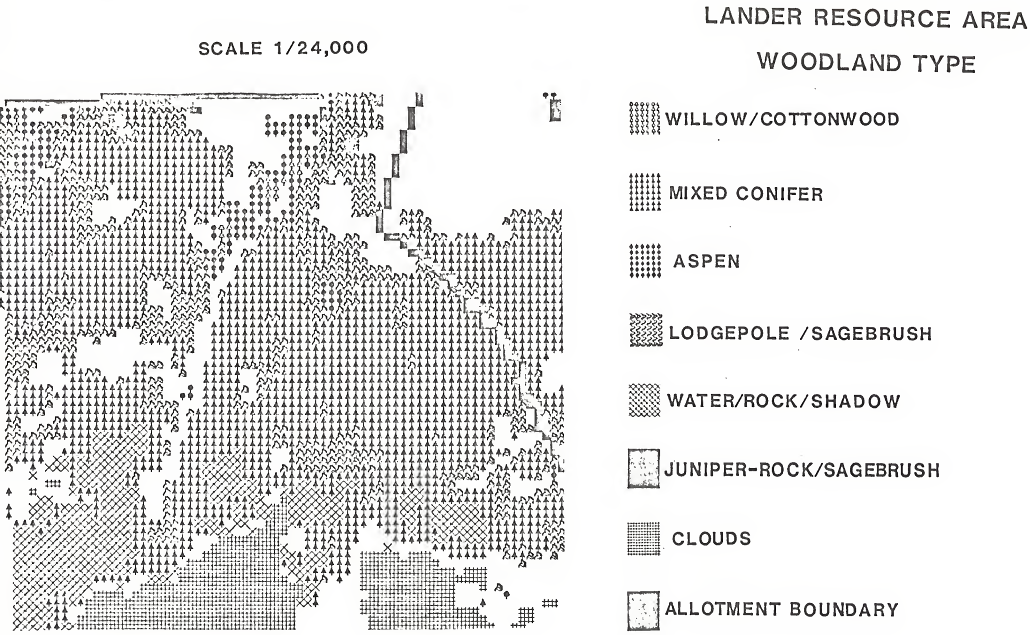


Figure 6. Woodland Types Displayed for a portion of the Sagebrush Park 7.5 Minute Quadrangle

respectively. The final distance to water classes corresponded to BLM's criteria of the distances that cattle will travel up slope. The slope image (described in section 5.2.2.5) were combined with the distance-to-water image. The IDIMS function ADD was applied. Each data value in the output image contained two digits. The first digit indicated the distance-to-water and the second digit was the slope class.

A list of 7.5 Gas Hills quadrangles, supplied by the LRA office, was used to extract the data for the areas of interest. The IDIMS functions STRATCPY, MAGNIFY, and SYMBPLOT was applied to generate the VERSATEC symbol maps. The SYMBPLOT pattern file "Alphanum" was used to assign the map symbols to the distance to water and slope class data values. A photocopied portion of the Torrey Lake quadrangle range suitability product is provided in Figure 7.

5.3.3.6 Tabular Data Summaries by Allotment

The last output products generated contained acreage summaries of land cover type and land status (ownership) tabulated within each allotment. The ownership and allotment data was contained in STRATA files which were generated following the completion of the digitizing task (Section 5.2.3). The land cover data resided in image related files that contained 16 land cover classes for Lander Resource Area (excluding DuBois) and 13 classes in the DuBois P.U. image.

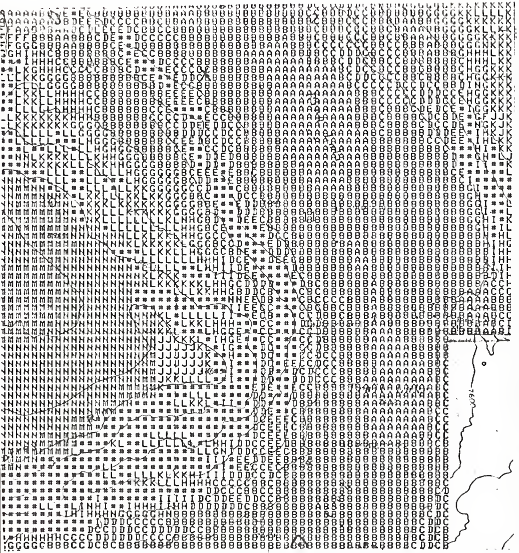
First, a program was written to re-number or increment the allotment data into a new file that would be easier to use with POLYSUM. The IDIMS function POLYSUM applied the ownership and allotment strata files to the land cover input image. The allotment data was contained in five separate STRATA files, therefore, POLYSUM was run 5 times. The ERIS program APPEND combined the 5 files into one. The ERIS program SORT sorted the land cover data by allotment number and the ownership, as specified by the analyst. SAMPAMAL amalgamated the sorted input file by combining the allotment and ownership cases of the same class.

A special program called "PTABLES" was written to print out the tabular data summaries. PTABLES resided in the MINITAB software and the program accepted real or double precision data from the file created by SAMPAMAL. The analysts specified a page top heading and a subheading that was printed on each page of the tabular summaries. The analyst typed in the allotment, ownership, and land cover names, and assigned their associated code values to those labels. Some of the land cover names had to be abbreviated because the program was limited to a 15 character description. Complete tabular summaries were printed for the DuBois PU and Lander Resource Area. An example of the tabular summary for allotment #1333 is shown in Table 2.

GASHILLS E.S. AREA

RANGE SUITABILITY ON THE BASIS OF DISTANCE TO WATER AND SLOPE PERCENT CRITERIA ONLY

SCALE 1/24,000



AAAAAA	0 to 0.3 miles to water, 0% slope
BBBBBB	0 to 0.3 miles to water, 1-20% slope
CCCCCC	0 to 0.3 miles to water, 21-30% slope
DDDDDD	0 to 0.3 miles to water, 31-40% slope
EEEEEE	0 to 0.3 miles to water, 41-50% slope
FFFFFF	0.3 to 0.4 miles to water, 0% slope
GGGGGG	0.3 to 0.4 miles to water, 1-20% slope
HHHHHH	0.3 to 0.4 miles to water, 21-30% slope
IIIIII	0.3 to 0.4 miles to water, 31-40% slope
JJJJJJ	0.4 to 0.6 miles to water, 0% slope
KKKKKK	0.4 to 0.6 miles to water, 1-20% slope
LLLLLL	0.4 to 0.6 miles to water, 21-30% slope
MMMMMM	0.6 to 4.0 miles to water, 0% slope
NNNNNN	0.6 to 4.0 miles to water, 1-20% slope
■■■■■■	greater than 50% slope - unsuitable range

Figure 7. Range Suitability Displayed on a portion of the Torrey Lake 7.5 Minute Topographic Quadrangle

LANDER RESOURCE AREA-REMOTE SENSING PROJECT DATA SUMMARIES

ALLOTMENT 1333

LAND COVER ACREAGE COMPILED BY OWNERSHIP CLASS WITHIN ALLOTMENT

LAND COVER TYPE	NO OWNERSP	BLM	STATE	PRIVATE	USFWS	STATE H2O	BUR OF REC	INDIAN RS	TOTAL
H2O-SHADOW-ROCK	0	1	0	1	0	0	0	0	
LOW DENS GRASS	0	1086	145	80	0	0	0	0	131
JUNIPER RK-SAGE	0	14	11	120	0	0	0	0	14
SAGE-ROCKY SOIL	0	8	14	114	0	0	0	0	13
H.DEN SAGE-GSWD	0	4	8	78	0	0	0	0	9
MED DENS SAGE	0	10	40	225	0	0	0	0	27
SAGE-MIX GRASS	0	418	50	247	0	0	0	0	71
MIX GRASS-SAGE	0	11211	1283	1559	0	0	0	0	1415
RIP.GRASS-SAGE	0	0	0	5	0	0	0	0	6
TOTAL	0	12755	1554	2535	0	0	0	0	1681

Table 2. Example Of Remote Sensing Data Summary Report For Allotment 1333.

6.0 Delivered Products

The last section will document the dates of output product delivery, the number of maps delivered, and additional preparation required to package the maps and tabular data in their final form. Correspondence and indexes of deliverable products are documented in the appendices.

6.1 Gas Hills Soil-Spectral Maps

Soils overlays (received from WSO) and the spectral maps were manually registered. A light table was used to overlay the spectral maps on a topographic map or orthophoto and draw in the map corners in their corresponding location on the spectral maps. Next, the soil maps were hand registered to the spectral maps. The labelled soil-spectral map products were laminated at Perma-Graphics in Denver to maintain registration and provide a durable field product. Thirty soil-spectral maps were delivered to the Rawlins District prior to the FY82 field season. The majority of the maps were delivered in early April (Append. A). The remaining few were delivered in May after the soils overlays were recieved from WSO (Append. B).

6.2 Lander Resource Area Land Cover Maps

The LRA land cover symbol maps plotted on the Versatec were trimmed, labelled, and taken to the BLM Photo Lab to be photographed on film transparencies. One hundred and twenty film transparencies were delivered in two shipments to the LRA office in October (Append. C-1).

6.3 DuBois Planning Unit 7.5 Minute Land Cover Maps

DuBois land cover maps were generated on the Applicon ink-jet plotter. Eleven color coded maps were trimmed, labelled, and laminated at Perma-Graphics. A separate legend was prepared and laminated also. The delivery of the DuBois land cover maps was delayed until late October, when the money for lamination was approved. Appendix C-2 is an index of the delivered land cover maps for the entire LRA.

6.4 Lander Resource Area and DuBois Planning Unit Small Scale Land Cover Maps

The LRA and DuBois land cover maps were generated at 1:250,000 and 1:126,720 respectively. These small scale maps provide a synoptic view of the land cover types and allotment boundaries for the entire resource area. These maps were provided for general reference and were not intended for field use. These maps were delivered to the LRA & WSO in late October.

6.5 Lander Resource Area Woodland Type Maps

Woodland types were generated on the Versatec plotter. They were trimmed, labelled, and sent to the BLM Photo Lab. The majority of the woodland type maps (transparencies) were mailed on October 13 with the bulk of the land cover maps. The remainder of the woodland maps were mailed on October 29 (Append. C-1). An index of the 53 delivered woodland maps is provided in Appendix D.

6.6 Gas Hills 7.5 Minute Range Suitability Maps

The range suitability (slope and distance to water) maps were plotted on the Versatec, trimmed, labelled, and sent to the Photo Lab for reproduction. Eleven map transparencies for DuBois Planning Unit and 62 map transparencies for LRA were mailed to the LRA offices on October 29 (Append. C-1). An index of the delivered range suitability maps is provided in Appendix E.

6.7 Lander Resource Area and DuBois Planning Unit Tabular Data Summaries

The tabular data summaries generated on the line printer were trimmed to notebook size. The summaries were hand sorted in ascending numerical order, indexed, punched, and put into a notebook. The notebooks were prepared in early November but were not delivered until the final project review meeting in January.

7.0 Project Review

Project reviews were conducted in June 1982 (a final review of soil-spectral map products) and January 1983. Project reviews were necessary to: 1) evaluate the utility of delivered products, 2) assess any future requirements, and 3) listen to any suggestions that would enable SSA to be more responsive to the BLM field office's information needs.

7.1 Gas Hills Field Review

The field review of the Gas Hills soil-spectral map products was conducted from June 14 & 15. A trip report was written to document the field activities conducted and to summarize the opinions and recommendations of the field evaluation team in regard to the utility of the map products. Appendix F is the field trip report that documents these findings.

7.2 Lander Resource Area Project Review

A final project review and debriefing was conducted on January 6, 1983. A trip report was written to document the activities and conclusions reached at the meeting. A copy of the trip report has been included as Appendix G.

8.0 Cost Estimates

Itemized costs of the LRA remote sensing project have been tabulated. The costs include project related activities performed by SSA. Not included in these costs are salaries, travel or any costs incurred by the LRA, and RDO or WSO offices in their association with the project.

Actual costs were recorded where receipts or records were available for documentation (e.g., labor, travel, Landsat & terrain data). Computer costs were computed on the basis of an estimated commercial rate of CPU and connect time. In the case where the actual cost of an item was not easily determined, a qualified estimate was made. For example, the director of the BLM Photo Lab provided an estimate of hours per unit cost (materials and labor) to make a photographic transparency from a paper original at 1:24,000. Likewise, other costs were approximated by relying on a source who could make the most educated estimate. An attempt was made to include all cost items. Because there may have been hidden costs or unknown costs that the author was not aware of, a 3% contingency cost was added to the total of all itemized costs.

The total estimated cost of the LRA remote sensing project was ~~estimated at~~ $90,682.20. By dividing this figure by the estimated acreage of the entire LRA (Green Mountain and Gas Hills ES areas) or 2,364,000 acres, the total cost per acre was $.04. One might conclude that the costs of producing all of the maps and tabular products for LRA, RDO, and WSO, discussed in this document, was approximately 4 cents per acre. No attempt was made to break down the costs by planning unit or ES area. Appendix H includes the summary tables of all costs associated with the project.

Appendix A

Documentation of the April delivery of soil-spectral maps to Rawlins district Office

Technicolor Graphic
Services, Inc.

April 1, 1982

Mr. Don Glenn
SVIM Supervisor
Rawlins District Office (BLM)
P.O. Box 670
1300 - Third Street
Rawlins, Wyoming 82301

Dear Don:

Being sent under separate cover, are nineteen (19) Soil-Spectral map products for the Gas Hills ES area. The names of the quad sheets are listed below:

1. Depass
2. Arapahoe Butte
3. Cottonwood Pass
4. Bonneville
5. Picard Ranch
6. Gates Butte
7. Hidden Valley
8. Lysite
9. Squaw Butte, NE
10. Moneta
11. Madden
12. Haybarn Hill
13. Squaw Butte
14. Seventy-One Reservoir
15. Moneta SE
16. Love Ranch
17. Fuller Reservoir
18. Campbell Ridge
19. Miles Ranch

With the addition of the three maps that I delivered to you at the Cheyenne eeting, (Birdseye Pass, Lysite SE, and Ocla Draw), this brings the total to wenty-two (22) maps.

Guffy Peak was misregistered during the lamination process. Bruce Keating is ending me another soils map for Guffy Peak and we will try it again. Shoshoni, ndian Butte, and Coyote Springs spectral maps will be plotted tomorrow. I have ist received Double Butte and Butte Well soils maps. Bruce Keating will send me cIntosh Meadows and Lankin Dome soils maps as soon as they can be reproduced by the oils labs.

Technicolor Graphic
Services, Inc.

April 12, 1982

Mr. Don Glenn, Svim Supervisor
Bureau of Land Management
PO Box 670
1300 Third Street
Rawlins, Wyoming 82301

Dear Don:

Enclosed are the remainder of the soil-spectral maps for Gas Hills. The maps enclosed include:

1. Shoshoni
2. McIntosh Meadows
3. Larkin Dome
4. Coyote Springs
5. Guffy Peak
6. Indian Butte
7. Double Butte
8. Butte Well

Please advise me on the status of Puddle Springs, Gas Hills, Black Rock Gap, and Split Rock soils overlays. Let me know if you want the laminated spectral maps for these quads before we receive the soil overlays. Do you require any spectral maps for other quads in Gas Hills where soils have not been mapped? If you anticipate any future requirements or have any questions, give me a call.

Sincerely,

Steven A. Sader, Ph.D.
Applications Scientist

SS/ia

cc: Bruce Keating
Dave Linden
Lorin Schwartz

Building 50 · Mail Stop D 234 · Denver Federal Center · Denver Colorado 80225 · Telephone (303) 234 6730

Instead of sending these eight maps in groups, I will wait until they are all ready and send them together in a couple of weeks. The remaining eight maps will reach you in plenty of time, if you do not plan on using these products in the field until May, as you mentioned at the Cheyenne meeting. Let me know if there are any questions.

Sincerely,

Steven A. Sader

Steven A. Sader, Ph.D.
Applications Scientist

AS/ls

:: Bruce Keating
Dave Linden ✓

Appendix B

Documentation of the may delivery of soil-spectral maps to the Rawlins District Office

Technicolor Graphic
Services, Inc.

May 18, 1982

Mr. Don Glenn
Bureau of Land Management
P.O. Box 670
1300 Third Street
Rawlins, Wyoming 82301

Dear Don:

Enclosed, are the following Gas Hills soil-spectral maps:

1. Boysen
2. Gas Hills
3. Bonneville SW
4. Puddle Springs
5. Alkali Butte

For some reason, the color plotter would not read the tape that had the split rock data on it. I will have to write that image to tape again and replot it. As we discussed on the phone, I would like to look at some of the maps in the field with you or Andy. Next week would be fine or whenever would be a convenient time to work into your field schedule.

Sincerely,

Steven A. Sader, Ph.D.
Applications Scientist

SAS/ls

Enclosure

Building 50 · Mail Stop D-234 · Denver Federal Center · Denver, Colorado 80225 · Telephone (303) 234 6730

Appendix C-1

Documentation of the October delivery of land cover, woodland type, and range suitability to the Lander Resource Area Office

Technicolor Graphic
Services, Inc.

Roy Packer
Range Conservationist
USDI-BLM
P.O. Box 589
Jett Bldg. Hwy 287 South
Lander, Wy. 82520

October 13,1982

Dear Roy:

Today I am sending the woodland type maps and land cover maps for Lander Resource Area. I have enclosed an index of both woodland type and land cover maps with a check mark for those maps that are enclosed in the film boxes. Check the maps against the index and let me know if anything is missing.

The woodland type map of "Miner's Delight" will come in the shipment with the range suitability maps. The range suitability maps are ready to send to the photo lab. The land cover maps of "Fossil Hill, Antelope Reservoir and Osborne Well" will come with that shipment.

Legends are enclosed in the film boxes, but I have included one of each with this letter. All color maps need to be laminated. We are beginning to generate the tabular data.

I am an instructor in the Reno photo interpretation training course, so I will be out of the office until Oct. 25th. I hope to have somebody work on the remaining output products while I am gone.

I will schedule a trip to Lander during the first week of November. I will be available to discuss the output products and answer any questions you or others may have. I will call when I return from Reno to set up a time for my visit.

Sincerely,

Steven A. Sader, Ph.D.
Forest and Range Applications Scientist

BUILDING 50 · MAIL STOP D-234 · DENVER FEDERAL CENTER · DENVER, COLORADO 80225 · TELEPHONE (303) 234-6730

October 29, 1982

Roy Packer
Lander Resource Area USDI-BLM
P.O. Box 589
Jett Building, Hwy. 287 South
Lander, Wyoming 82520

Dear Roy:

In separate map tubes, I am sending the range suitability maps and the remainder of the land cover and woodland type maps. I have enclosed indexes to indicate the maps being sent to you: Miners Delight (woodland type); Fossil Hill, Benton Basin SW, Antelope Reservoir, and Osborne Well (land cover type).

I am sending all of the range suitability maps except Shoshoni which has just been sent to the photo lab and will take a few days to get back. A legend for the range suitability maps is enclosed. I am working on the tabular data and hope to hand deliver them when I come to Lander to review all of the output products.

Sincerely,

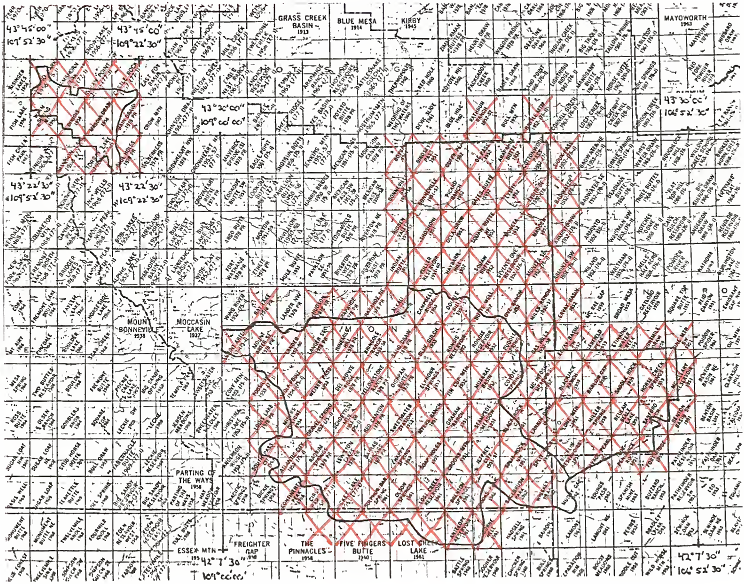
Steven A. Sader, Ph.D.
Forest and Range Applications
Scientist

SAS/ls
Enclosure

cc: Lorin Schwartz
Gregg Johnson
John Szajgin
Bruce Keating

Appendix C-2

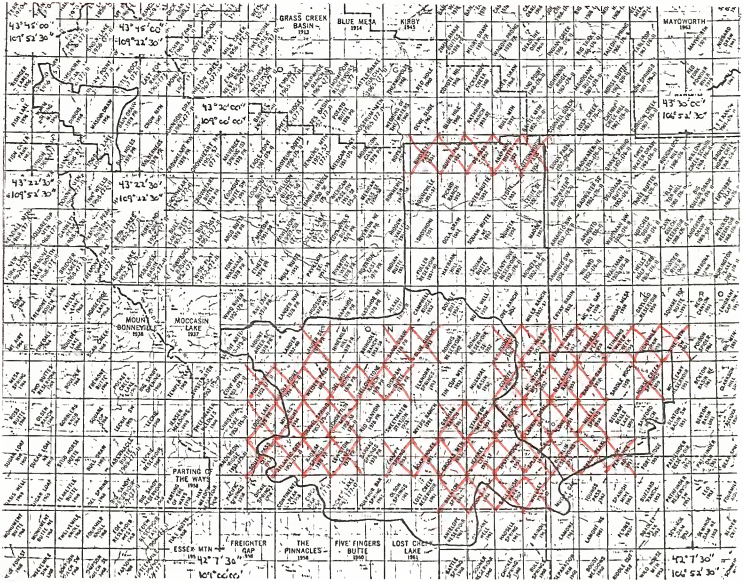
Index of land cover maps delivered to the Lander Resource Area Office



43°45'00"
109°52'30"
43°45'00"
109°22'30"
43°20'00"
109°00'00"
43°30'00"
106°52'30"
43°22'30"
109°52'30"
43°22'30"
109°22'30"
42°7'30"
109°00'00"
42°7'30"
106°52'30"
GRASS CREEK BASIN 1913
BLUE MESA 1914
KIRBY 1945
MAYOWORTH 1963
MOUNT BONNEVILLE 1938
MOCCASIN LAKE 1937
PARTING OF THE WAYS 1958
ESSEX MTN 1953
FREIGHTER GAP 1958
THE PINNACLES 1958
FIVE FINGERS BUTTE 1960
LOST CREEK LAKE 1961

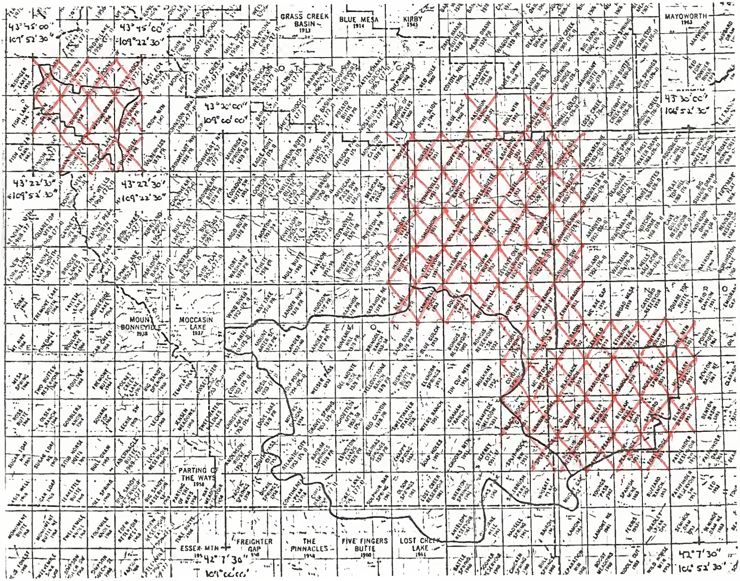
Appendix D

Index of the woodland type maps delivered to the Lander Resource Area Office


43°45'00"
109°52'30"
43°45'00"
109°22'30"
GRASS CREEK BASIN 1913
BLUE MESA 1914
KIRBY 1945
MAYOWORTH 1963
43°30'00"
109°00'00"
43°30'00"
106°52'30"
43°22'30"
109°52'30"
43°22'30'
109°22'30"
MOUNT BONNEYVILLE 1938
MOCCASIN LAKE 1937
PARTING OF THE WAYS 1958
ESSEX MTN
42°7'30"
109°00'00'
FREIGHTER GAP 1958
THE PINNACLES 1958
FIVE FINGERS BUTTE 1960
LOST CREEK LAKE 1961
42°7'30"
106°52'30"

Appendix E

Index of range suitability maps delivered to the Lander Resource Area Office


43°45'00"
109°52'30"
43°45'00"
109°22'30"
GRASS CREEK BASIN 1913
BLUE MESA 1914
KIRBY 1945
MAYOWORTH 1963
43°30'00"
109°00'00"
43°30'00"
106°52'30"
43°22'30"
109°52'30"
43°22'30"
109°22'30"
MOUNT BONNEVILLE 1938
MOCCASIN LAKE 1937
PARTING OF THE WAYS 1958
ESSEX MTN
FREIGHTER GAP
THE PINNACLES 1958
FIVE FINGERS BUTTE 1960
LOST CREEK LAKE 1961
42°7'30"
109°00'00"
42°7'30"
106°52'30"

Appendix F

Trip report documenting the field review of the soil-spectral map products

28C

Technicolor.

INTEROFFICE CORRESPONDENCE

The Record

DATE July 2, 1982

COPIES
L. Schwartz
B. Bonner
G. Johnson
D. Linden
S. Sader
B. Keating
Bus. Chron.
SAS Chron.

OM Steve Sader

BJECT Lander and Gas Hills Trip Report (6/14/82-6/18/82)

The purpose of the trip was to accompany the Rawlins District SVIM team in the field to evaluate the soil-spectral maps produced by SSA for the Gas Hills ES area. Also, preliminary vegetation maps were reviewed in the field with Lander Resource Area personnel to determine what revisions, in spectral class grouping, will be necessary to create a more accurate vegetation map.

During the two days spent with Andy Warren (RDO), the following areas were visited: Love Ranch, Gas Hills, Bonneville, Birdseye Pass, Picard Ranch and Shoshoni quads. The field teams are mapping range sites and condition class as well as gathering some wildlife data. The field crews are quite experienced as most of them have returned for the third or fourth straight year. They have a helicopter at their disposal for the entire field season.

The soils have been mapped on good quality orthophotos. The inventory procedure requires that 100% of the soil polygons are visited as range site and condition class is recorded. If a fence crosses the soil polygon, both sides have to be conditioned. Range condition is based on species composition and the vegetative condition of the site as it relates to the theoretical climax vegetation. Ultimately grazing allocations are determined on the basis of range condition and other considerations. Therefore, it is important that species composition and range condition are evaluated carefully.

There are major limitations to the use of the Landsat spectral maps (combined with soil overlays) for deriving range sites and condition class. Because vegetation canopy cover rarely exceeds 40% (non-riparian types), the soil and ground surface exhibit a major influence on spectral response. As one would expect, some of the spectral classes do not appear to represent exclusively one vegetation or informat[illegible] class. This situation causes the user to have a lack of confidence in the spectral map because the spectral classes are not always good predictors of a specific vegetation type.

The concensus of opinion of John Likens (LRA), Andy Warren (RDO), Roy Packer (LRA) and myself is that data required to derive range site and condition is too detailed and site specific (field intensive) to be determined by the coarse resolution of Landsat data. The spectral maps would be more applicable to a pre-inventory phase or prior to a soil survey. For example, the spectral maps may help to flag anomalous units within otherwise homogeneous areas or major land resource areas (MLRA's), thus indicating to the soil scientist where soil pits should be dug to classify the soil. There are spectral patterns exhibited that are often not apparent or as obvious on orthophotos. In areas where orthophotos are not available, the spectral maps would be even more useful. This type of procedure is being applied by the SCS in Arizona through cooperation with the Havasu Resource Area project. During a field review in Arizona last March, Russ Barimore (SCS) claimed that SCS can map soils on an orthophoto quad in almost 1/2 of the time that it would require to map soils without the aid of the spectral maps. The reason for the increased efficiency is that they spend less time driving and walking to determine representative areas to dig soil pits.

The rest of field trip was spent with Lander Resource Area range conservationists, visiting several areas throughout LRA to compare vegetation types, designated on polaroid color prints, with actual ground conditions. The revised spectral class grouping appeared to represent ground conditions more satisfactorily than the preliminary classification. There are still some classes that exhibit some inconsistencies in the type of vegetative and ground cover that is actually represented. These problem classes in particular will be the focus of examination when Roy Packer returns in early July to perform the final class grouping of vegetation and land cover classes.

Steve Sader

SAS:ia

Appendix G

Trip report documenting the final project review at the Lander Resource Area Office

Form 28C

Technicolor.
INTEROFFICE CORRESPONDENCE

TO The Record

DATE Jan. 17, 1983

COPIES
L. Schwartz
G. Johnson
Bus. Chron.
SAS Chron.
SAS ✓

FROM Steve Sader

SUBJECT Lander Resource Area Project Review

The Lander Resource Area (LRA) final project review was conducted in Lander, Wyoming on January 6, 1983. The Lander Resource Area Manager requested that Steve Sader provide a project debriefing to the LRA resource staff and present output products generated for the remote sensing project. Approximately 20 BLM resource specialists attended the project review. Bruce Keating (WSO), Roger Mertens (WSO), and Don Glenn (RDO) were also in attendance.

Most of the LRA staff had little previous knowledge of the project and had not seen any of the output products prior to the meeting. Considerable interest in the output products was expressed by several LRA staff members. The LRA Forester compared a computer-generated woodland type map with a topographic map to observe an area familiar to him on the Sagebrush Park 7.5 minute quadrangle. He was pleasantly surprised that the woodland types (primarily Conifer and Aspen) appeared to be an accurate representation of the location and distribution of vegetation in the area.

There were two inquiries into the availability of additional copies of the 7.5 minute land cover maps. A request was made by the wildlife specialist to produce the LRA land cover map (Applicon color product) at the URA scale of 1:126,720. Selected output products representative of the LRA project will be copied as display examples for SSA. All of the Versatec paper plots (originals) will be sent to Roy Packer (LRA). It will be LRA's responsibility to store and copy the map products as they desire.

The principals on the LRA project (Roy Packer, John Likens, and Don Glenn) were satisfied with the project outcome and output products. They could envision some useful applications of the maps and tabular data. Roy Packer was especially pleased with the range suitability maps because the task of delineating the range suitability zones was done previously by arduous and time-consuming manual methods. The tabular data provides listings of land cover and ownership acreage by allotment that has never been available before. The tabular summaries will be useful to support the Gas Hill E.S. and other management documents that will be submitted by the LRA office. A final project report will be submitted to each participating office in late January.

Steve Sader
SS/ls
SAS

Appendix H

Cost Summary For Lander Resource Area Remote Sensing Project

Lander Resource Area Remote Sensing Project

Cost Summary

Computer		$40,355.82
Labor		$40,393.00
Travel		$ 1,974.23
Landsat Data		$ 1,200.00
Terrain Data		$ 525.00
USGS Maps		$ 28.00
Perma-Graphics		$ 249.42
BLM Photo Lab		$ 2,674.30
Dunn Camera		$ 250.00
Applicon Maps		$ 391.00
	Total	$88,040.77
	Add 3% Contingency	$ 2,641.22
	Grand Total	$90,681.99

Green Mountain E.S.	1,338,000 acres
Gas Hills E.S. (including DuBois PU)	1,026,000 acres
	2,364,000 acres

90682/2,364,000 acres = $.04/acre

Lander Resource Area Remote Sensing Project

Itemized Costs

Computer		
DPU	$ 2,155.53	
LRA	$38,200.29	
	$40,355.82	$40,355.82
Labor		
Direct Labor Hours 2882.5		$36,015.00
Direct Labor Overhead		4,378.00
Total		$40,393.00
Travel		
10/03/81	$ 60.46	
11/06/81	$219.00	
11/14/81	$405.16	
1/09/82	$401.75	
4/10/82	$201.17	
1/02/82	$421.77	
1/06/83	$264.92	
	$1,974.23	$ 1,974.23
Landsat Tapes & Imagery		
LRA	$1,000.00	
DPU	$ 200.00	$ 1,200.00
DMA Terrain Data		
$75/1° x 1° Quad x 7 Quads		$ 525.00
USGS Maps		
20 Maps @ $2.00 -30% Discount		$ 28.00
Perma-Graphics (map lamination) @ $.01/sq. inch		
DuBois PU 1:126,720 Scale-224 sq. in. x 3 maps =		$ 6.72
LRA 1:250,000 Scale - 810 sq. in. x 3 maps =		$ 24.30
DuBois 1:24,000 Scale - 546 sq. in. x 10 maps =		$ 54.60
Gas Hills 1:24,000 Scale-546 sq. in. x 30 maps =		$ 163.80
Total		$ 249.42
BLM Photo Lab Reproduction @ $3.00 sq. ft. Materials & Labor		
$3.00 sq. ft. x $3.79 sq. ft. = $11.38/Map		
Land Cover 120 Maps x $11.38/map =		$ 1,365.60
Woodland Type 53 Maps x $11.38/Map =		$ 603.14
Range Suitability 62 Maps x $11.38/Map		$ 705.56
Total		2,674.30
Dunn Camera 50 Photos @ $5.00/Photo		$ 250.00
Applicon Map Generation 46 Plots @ $8.50 = (materials & Labor)		$ 391.00

Lander Resource Area Remote Sensing Project

Computer Cost Monthly Accounting - Gas Hills Account

Month	$ IDIMS	$ GIS	$ $\mathrm{I}^2\mathrm{S}$	$ ERIS	$ LINDEN	Total
October 1981	291.48					291.48
November 1981	1,761.69	243.57				2,005.26
December 1981	1,792.26	1,770.06				3,562.32
January 1982	2,006.28	3,473.76		14.34	7.92	5,502.30
February 1982	5,191.32	924.66			10.02	6,126.00
March 1982	1,567.38	397.53	4,020.48			5,985.39
April 1982	1,221.87	132.45	1,162.44			2,516.76
May 1982	673.05	63.78	606.45			1,343.28
June 1982	1,258.74	329.55	116.31		200.49	1,905.09
July 1982	1,410.66	724.53	214.95		33.33	2,383.47
August 1982	1,513.68	2.49			6.75	1,522.92
September 1982	945.60	220.80	162.48		21.27	1,350.15
October 1982	2,032.14	232.62	555.84	84.60	50.85	2,956.05
November 1982	307.23	10.32	2.10	310.56	.69	630.90
December 1982	91.26	21.84		5.16	.66	118.92
Total	22,064.64	8,547.96	6,841.05	414.66	331.98	38,200.29

Computer Cost Monthly Accounting - DuBois Account

Month	IDIMS	GIS	I^2S	ERIS	LINDEN	Total
November 1981						-0-
December 1981		307.11				307.11
January 1982	142.55	334.63				477.18
February 1982	208.47	12.66				221.13
March 1982	1.86	.39				2.25
April 1982						-0-
May 1982	330.57					330.57
June 1982	196.68	105.39			8.04	310.11
July 1982	272.37	10.20				282.57
August 1982		.42				.42
September 1982	189.78					189.78
October 1982						-0-
November 1982	1.17	.42			.69	2.28
December 1982	23.40	8.73				32.13
Total	1,366.85	779.95	-0-	-0-	8.73	2,155.53

DRAFT 2

5/12/83

Bill Bowen

- Information for User's Guide Book -

Application to Land Use Planning or EIS

Introduction

Upon completion of soil and ~~b~~vegetation inventories a computer data file will exist and may be used in other BLM programs. Data contained in the computer file may be manipulated and analyzed to produce various maps, overlays, and tabulations. Many resource analysis functions of land use planning or EIS preparation may be facilitated through such computer analysis.

1. Computer File

A. Typical Computer File Data

A typical data file, compiled during soil and vegetation inventories, should contain data concerning the following:

Soil ~~Classification~~ -
- Soil ~~series~~ map (digital)
- Soil ~~properties~~ INTERPRETATIONS (key punched)
  - ~~Characteristics~~
  - Productivity
  - Limitations
  - POTENTIALS

Range Site -

Range site map (digital)

Range site/condition class description (key punched)

PRESENT PLANT ~~Vegetation~~ communities seral stage map (digital)

Rangeland condition CLASS statification (digital)

Land Information - (digital)

Land form

Digital terrain data (slope, aspect, elevation)

Geology

Environmental Information - (digital)

Precipitation isophetes

SOIL MOISTURE ZONES

Soil temperature zones

Water sources

Cultural Features - (digital)

TRANSMISSION LINE RIGHT-OF-WAYS

Water developments

Roads

Allotment bndy, fences

B. Data That May Be Reocrded

Data that may be added to the computer file and will enhance the computer analysis-machine mapping &/or tabulation are as follows:

Information from labor intensive or previous inventories

Soil maps and physical descriptions/capabilities

Vegetation information

Land uses

Land ownership status

II Computer Enhanced Analysis

A. Analysis Process

An inspection of typical and possible file data reveals the wealth of ecological and physical data that may be available on a given planning area. The fullest utility of the file information may be achieved through machine enhanced analysis. The software packages used in such analysis of data for soil and vegetation classification may also be used to analyze and manipulate data for land use plannine or EIS.

Prior to preforming data manipulation and analysis to produce specific maps, overlays, and tabulation the user must clearly identify product objectives and probable uses. The objectives and probable uses will then be useful as a guide for determining what file data to use and what analysis pparameters to emply. Also of equal importance are identification of specific file data and careful determinination of product format. These functions are critical to the production of a useable and reliable product. An example of a product development process follows:

objective - Potential Pinyon Juniper chaining and seeding areas.

file data required: P.J. woodland, digital terrain data, soil data, preceipitation data, vegetation inventory data and range soils.

analysis parameters: P.J. thru 30% conapy cover.
slopes 20%

Ppt 10"

type

soils.. specify series/phases

P.J. 75% q veg. production on site.

range site -- specify range site.

product format: overlay 1:100,000, tabular display by allotment.

The computer process searches the file for P.J. woodland and manipulates the PJ strata within analysis parameters to select suitable potential PJ chaining areas. These data are then feed to a computer compatable tape for processing as a 1:100,000 scale overlay and tabulation by management allotments.

B. Products that may be Produced

Computer enhanced analysis and output products will depend upon the extent of the computer file. Following are some typical examples of products following file development through soil and vegetation inventory:

1. Land use Planning and EIS Information

Products overlays/tabulation	File data needs (not enclusive)
Potential Land Use	Soils given and physical characteristics, Land form, elevation, slope, Ppt.

	Land Treatment Potential	Soils Information, Ppt, Temp. Digital terrain data, Range site, vegetation community and condition class.
	Elevation/Slope maps	Digital Terrain data, Land form
	Erasion Hazard	Soils data, vegetation cover data, Slope, Land form
	Soil Association	Soils data file
	Limiting Factors	Soils data, Digital terrain, Land form, Temp. Ppt
Combine	Forest or Woodland Stand	Forest Inventory data Vegetation data, soil data, Elevation, Land Form, Ppt, Temp.
	Shrub/grass ~~Vegetation~~ Communities	Vegetation Inv. data file, Range site data file, Condition Class Allotment bndy, Production data
	~~Range Condition Classes~~	~~Range site data file~~, ~~Allotment bndy~~

Range Suitability	Present Range Production data, Digital terrain data, Water File, Fence location
Wildlife Habitat Area	Land form, digital terrain data, Present Vegetation production data, phenology Ecological ~~Range~~ site data, Water File, Raod file, Ppt

This listing represents the typical capability of the data base. As one work with a given planning or EIS project one may recognize addition capability for products.

2. Management Application

The data file may be utilized through a computer enhanced analysis to produce maps and tables for appication in a current management problem. Here as in planning one must clearly define the objectives, the probable user, required file data, analysis parameters and the desired product format. There are limits to practical application; however, within those limits are vast opportunities for data use. Such use of high technology in our dialy management will significantly improve our overall efficiency and accuracy.

Soils and Vegetation Inventory suggestions

1. Mult stage sample for soils and vegetation.

Define the process in logman terms.

User must clearly understand. Not a panaced.

The potential in savings in compiling inventory.

Requires approved 6 to 9 mo. lead time.

Utilize a standard accepted classificatin framework -

UNESSO Plant Community ~~Vegetation/Soils~~ classification ~~scheme~~ (Ft. Collins)
Soil Taxonomy

2. Use in soil Survey.

Data Required - MSS, digital terrain, alnd form, soil terrain zones.
Ppt data, geological data, aerial photos - mid scale IR

Process of classification

Supervised/unsupervised training site with given environmental parameters - elev., land form, geology, Ppt. Temperature.

Review in lab for refinement.

Field sample sets to truth.

Final refine field truth, etc.

Produce preliminary soil map, soil map units (association of soil taxons ~~series~~) go on overlays registered to ortho-photo quads.

Field Inventory. would utilized the preliminary classification and ancillary data maps to map soils to the series level, map scale dependent ~~(order III)~~.

Upon completion of soil survey.

Soil mapping digitized to form perm. computer tape of survey.

Soil ~~series~~ characteristics key punched for perm computer tape.

3. Use in vegetation Inventory

- Once soil survey complete, reliatively accurate ~~veg.~~ present plant community mapping may be accomplished.
- Soil maps ~~and~~ (That include land form, geolog~~ical~~y, elevation, slope and aspect ~~and~~ Ppt and temperature) are used to produce a ~~preliminary range~~ Ecological site map.
- Supervised/unsupervised training sets to ~~classify~~ identify present vegetation community~~/~~ ~~rangesite~~. ~~Use, elevation, Ppt, aspect, soils as classification parameters.~~
- Review in lab for refinement.
- Field sample sets for refinement. (select homogeneous areas for random sampling)
- Final map machine processed to match ortho quads for field ~~mapping~~ survey crews verification/correction and refinement to rangeland condition class- ~~Poor, fair or good.~~ early, mid, late and Climax.
- Final field map of ~~range~~ Ecological site/present plant community/condition class ditized as Perm. computer record.
- ~~Range~~ Ecological site/present plant community/condition class strata aggregated in tabuler form (statistics) Berkly Survey Planning Model could be used to make a stratified random sample and determine sample design (numbers and plot size) Sampling error goal of + 20% at a 80% comfidence level.
- Once field data is dompiled the information would be machine processed using available BLM ESL software packages.
- Information tabulated by ~~range~~ ecological site for allots and unit strata totals ~~Range~~ ecological site information and production could be key punch to enter the Perm. computer file.

Bill, the style of Bonner and Morgart, 1980 Publication is good for communicating to "Bumb Grass Grounds, etc".